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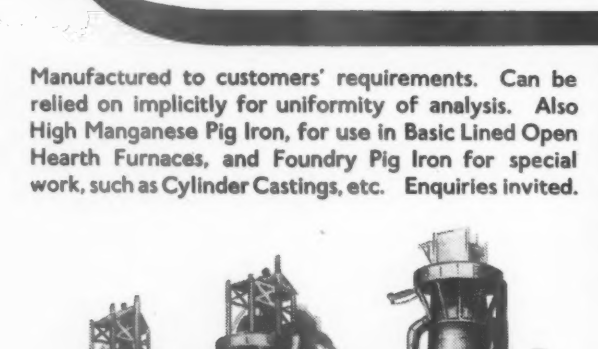

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FOUNDRY TRADE JOURNAL
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The Gas Industry

Of major importance to the foundry industry is the report which the British Gas Federation has submitted to the Minister of Fuel and Power on "The Planning of the Gas Industry." The foundry industry not only supplies a high percentage of the components used in equipping a gasworks, and practically the whole of its mains, but is a predominant factor in the sales of town's gas by the production of attractive cookers and stoves. In the Report there is expressed a desire to co-operate with other fuel supplying industries so that increased service to the customer may be given. This should benefit the foundry industry, for it is common gossip that no manufacturer of electric cookers ever received an adequate selling price, and to make ends meet put a little extra on the price of living-room fires. A stove which combines an electrically heated oven, carrying external gas rings for boiling, would obviously meet many people's desires. The gas industry, in its report, asks for the formation by the Ministry of Fuel and Power of a National Fuel Advisory Committee to facilitate the elimination of wasteful competition between the fuel industries, and to generate the spirit of constructive co-operation both in the interest of the national economy and of service to the individual fuel user. We hope that amongst the subjects the proposed Council will place upon its agenda will be the introduction of electric power into the gas industries, for in the past too much thought has been devoted to evading its adoption, and too little to the potential benefits. The Report rightly emphasises the amount of money spent annually in research—something of the order of £500,000. For the future, as a potentially profitable line of investigation, we would suggest an inquiry into the improvement of the gas engine, for this machine has not made the progress, especially in respect to weight per horsepower, that has been shown by the internal combustion engine using petrol as fuel. The wartime gas-driven motor-car points the way. An important recommendation contained in the Report is the formation of a British Gas Association to supersede various other bodies now in existence and to assume their functions. This body will consist mainly of representatives from the district councils, and it is interesting for foundrymen to note that the action the new body intends to take is the institution of a national accepted standardised costing system.

The third outstanding recommendation is the integration of undertakings throughout the country to provide a better service to the community after the war, and especially to accelerate the extension of gas into rural areas. So far as the foundry industry is concerned, this means that the number of its customers will be reduced and that there will be an enhanced tendency towards a few standardised designs. We note that on the Committee which prepared these were representatives of the foundry industry, yet to ensure future good relations the latter must be equally as well organised as its customers. There is a notion expressed in the Report that better organised buying will more equally distribute the load it imposes on the supplies of gas-burning appliances, and this, together with the production of standardised apparatus, will help with the export trade. An even manufacturing load is certainly helpful, but a design of cooker incorporating the best possible for the home market, is not necessarily equally acceptable abroad, as the composition of the meals to be cooked varies with geography, and features catering for this should be incorporated in the design. If, as is to be expected, gas is made available in rural areas, there should be a good market for small, well-designed gas engines for generating power in and about farmyards, but they will have to compete with the well-established oil engines.

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CENTRIFUGAL CASTING MACHINE

A vertical centrifugal casting machine for handling mould up to 24 in. in diameter and 12 in. in height has been placed on the market by the Centrifugal Casting Machine Company, Tulsa, Okla. This unit can be used to produce both ferrous and non-ferrous castings. The entire unit is integrated on a single base so that it may be moved about as a unit if necessary.

This machine is said to be especially suited for permanent mould centrifugal castings of bushings with dimensions such that the length of the bushing does not appreciably exceed the diameter. Smaller castings of a design not suitable for permanent moulds may be economically produced in dry-sand moulds.

The manufacturer of this unit reports that for the type of work most suitable for production on this machine continuously variable speed control is not necessary. However, the speed of rotation can be adjusted from 378 to 1,640 r.p.m. by varying the size of the sheaves on the table and on the motor.

It is claimed that tensile strength of non-ferrous alloys can be doubled, when centrifugally cast, while elongation can be trebled and hardness increased up to 20 per cent., the exact improvement being dependent upon the alloy cast. This machine is finding particular application in producing aircraft bearings. Properly made centrifugal castings, the company reports, can pass X-ray inspection better than 99 per cent.—"The Iron Age."

INSTITUTE CALENDAR MEETINGS FOR DECEMBER 1943

Dec. 4—*Lancashire Branch.*—"Modern Core-Sand Practice," by J. G. A. Skerl, D.Sc. At the Engineers' Club, Albert Square, Manchester, at 3 p.m.

Dec. 4—*Lincoln Section.*—"Some Work of the Technical Committee in Wartime," by J. W. Gardom. At the Technical College, Lincoln, at 3 p.m.

Dec. 4—*Wales and Monmouth Branch.*—"A Method of Correlating Foundry Production and Quality of Light Alloy Castings," by H. G. Warrington.

Dec. 11—"*Bristol Branch.*—"Light Alloys versus Ferrous Founding," by J. Roston. At the Grand Hotel, Bristol, at 3 p.m.

Dec. 11—*East Midlands Branch.*—"Cupola Theory and Control," by R. C. Tucker. At the Technical College, Derby, at 3 p.m.

Dec. 11—*Scottish Branch.*—Short Paper Competition. At the Royal Technical College, George Street, Glasgow, at 3 p.m.

Dec. 11—*West Riding of Yorkshire Branch.*—"Some Foundry Problems," by H. Balme. At the Technical College, Bradford, at 6.30 p.m.

ATOMIC-HYDROGEN FOR SALVAGING ALUMINIUM CASTINGS

Mr. H. A. Beaudoin, writing in "Metal and Alloys," recommends the adoption of atomic-hydrogen arc welding for the repair of imperfect aluminium castings. At the plant of a prominent Ohio castings manufacturer it has resulted in rejections of under 1 per cent. and saving of the company's investment in equipment in less than three months. Prior to being repaired by welding, the castings are preheated in a furnace that adjoins the welding booth. Metal of the same analysis as the base metal in castings is then deposited by a welding operator, who has passed special Air Corps qualification tests. Afterwards the completed welds are ground flush with the casting surface, and then it is impossible to detect the weld outline even by X-ray inspection and physical testing. The process was developed by the American General Electric Company. Experience shows that imperfect castings can be salvaged with no sacrifice of quality, regardless of the size of the original imperfection.

CORE AND MOULD CASTINGS

In a Paper presented before the Ontario Chapter of the American Foundrymen's Association, J. A. Ridderhof points out that the subject of core and mould coatings has received much less attention than other foundry phases. Coatings include core wash, blacking, plumbago and numerous special sprays and shake-ons, all having one purpose, improvement of castings surfaces. Factual data are given on composition of coatings, carrier liquids, mixing, consistency and control, application, drying nature of coatings, choice of type, defects, and specific applications in aluminium and steel work. The ideal coating material is one that is easy to apply, gives proper penetration and thickness of surface film to prevent fusion of sand or metal, does not run, flattens out on drying to a smooth surface, does not cause metal turbulence, is not washed off in pouring, and does not give off enough gas to cause blows. Depth of penetration and thickness of coating are important. Regardless of a coating's high quality, it will not correct poor sand, but may help correct such defects as roughness, sand fusion and cutting by the metal. Plumbago adheres better to sand on the wet side, and adheres better to coarse sand than fine sand.

German Aircraft Pistons.—An article submitted to us by the Ministry of Aircraft Production details an investigation undertaken by the Metallographic Department of the Research Laboratories of High Duty Alloys, Limited, on some light alloy pistons from German aircraft. Despite the interest which such an excellent article would create, we feel we cannot allocate space to it, because all the pistons examined by Dr. Wilson have been made as pressings from extruded blanks, and not as castings. This method of manufacture is now apparently standardised in Germany.

American Malleable Irons

BLACKHEART AND PEARLITIC MALLEABLE CAST IRONS

BUREAU OF MINES REPORT

Outline of American practice, composition, physical properties and uses of these irons, which are recommended as replacement materials

The possibility of replacing a material in many instances with another of similar properties, suitable for the specific application, but containing lesser amounts of strategic or critical elements, should be given consideration, points out Investigation No. 1213 of the Ore Dressing and Metallurgical Laboratories of the Bureau of Mines. This Report indicates that two materials which for certain applications may be alternatively used or satisfactorily substituted are blackheart malleable cast iron and pearlitic malleable cast iron. Blackheart malleable can be described as an iron which, as originally cast and of the proper composition, was extremely hard, brittle, and with a white fracture, then by subjection to a heat-treatment known as annealing or malleablising has been subsequently rendered soft, ductile and with a black fracture. Pearlitic malleable cast iron is a comparatively recent development in the malleable iron industry, and already has replaced steel forgings in certain applications. Blackheart and pearlitic malleable cast irons, although commencing as the same basic material, possess properties in the ultimate product that are considerably different; hence they are considered separately in the Bureau's Report.

BLACKHEART MALLEABLE CAST IRON

Blackheart malleable cast iron has been developed and used for over one hundred years in America, to the complete exclusion, for the past eighty years, of another variety of malleable cast iron which, from its fracture, is named "whiteheart." This latter type, which is made and has considerable use in Europe, is beyond the scope of the Report.

The making of satisfactory blackheart malleable iron castings requires the same care and attention to details that are necessary for the efficient founding of any metal. The molten metal required is obtained from various types of furnaces. Approximately 60 per cent. of the tonnage is produced in a type of reverberatory furnace, commonly known as the air furnace; about 10 per cent. is melted in cupolas, and the remainder is obtained by melting in cupolas, then superheating and refining in either air or electric furnaces. Installations of the last-mentioned process, known as "duplexing," are increasing, as it can supply hot metal continuously throughout the working day, an essential requirement for mechanised foundries.

The remaining foundry operations require the same attention and involve the same skill and good judgment necessary for the successful and efficient founding of all metals.

The annealing operation, in which the metal "as-cast" is heat-treated to yield the soft ductile product, is accomplished by two methods. The original method entails packing the "hard iron" castings into metal boxes or "pots" (omitting the active material that is added in the manufacture of "whiteheart"). The boxes, covered and hermetically sealed, are placed in ovens, or kilns, which are then closed up tightly. The oven is next heated up to a temperature of 900 to 950 deg. C. This temperature is maintained, depending upon the size of the oven and the total weight of the charge, for a period of from forty to sixty hours, then allowed to cool slowly to approximately 650 deg. C., after which the oven can be opened gradually and allowed to cool faster. This method of annealing is known as the "periodic." Although the quality of the metal annealed by this process is very satisfactory when proper precautions and control are employed, the annealing process is rather lengthy and time-consuming.

The second method was evolved from considerable study of the malleablising process, resulting in improvements in the heat-treating equipment, especially in the development of continuous type, controlled-atmosphere furnaces, either gas or electrically heated, with various zones of closely controlled temperatures. The time required for the complete cycle by this method varies from 18 to 36 hrs. The continuous, controlled-atmosphere method of annealing is very useful in the larger, mass-production-type foundries.

Composition

The compositions of blackheart malleable cast iron, whether made by the air furnace, the cupola, or one of the duplexing methods, are very similar, with only minor modifications. Chemical compositions of blackheart malleable cast iron, as noted in Table I, are for the "as cast" condition, since difficulty exists in obtaining satisfactory representative samples for chemical analysis from the annealed iron.

The manganese and sulphur contents should be

TABLE I.—*Composition Related to Process.*

Method of anneal	Periodic	Periodic	Short cycle, continuous
Melting unit	Air furnace	Cupola	Usually duplex
Carbon, per cent.	2.00 to 2.90	2.80 to 3.10	2.40 to 2.80
Silicon ,,	0.80 to 1.10	0.70 to 1.10	1.00 to 1.60
Manganese ,,	0.40 max.	0.40 to 0.60	0.40 max.
Sulphur ,,	0.12 max.	0.15 to 0.25	0.12 max.
Phosphorus,,	0.20 max.	0.20 max.	0.12 max.

American Malleable Irons

maintained in a definite ratio for satisfactory annealable metal. Generally the sulphur content in most blackheart malleable cast irons is 0.08 to 0.10 per cent., requiring a manganese content of 0.30 to 0.35 per cent. to maintain the proper ratio.

The chemical composition is not given in specifications, since the mechanical properties required may be met by a number of compositions, depending upon foundry practice and conditions. Castings made from any of the compositions given, with adjustments made for the cross-sectional size, should be, in the "as cast" condition, hard, brittle, and with a white fracture. This white fracture is due to the fact that during the solidification of the casting the composition of the metal does not permit the carbon present to be precipitated as graphite, and the carbon is retained entirely in chemical combination with the iron. Should any precipitation occur, the castings when malleablised will be of inferior quality, although some authorities believe that a slight amount of primary graphite is to be preferred to the possibility of internal shrinkage in the heavier sections of a casting.

During the annealing treatment, the iron-carbon compound is broken down into iron and carbon of the form known as "temper" carbon, which is responsible for the characteristic appearance of the fracture's surface, hence the name blackheart. Coincident with the changes that take place during the annealing, a certain amount of carbon is gradually eliminated from the immediate surface of the casting, resulting in a decarburised surface or "skin."

The structure of blackheart malleable castings, of the proper composition and correctly annealed, consists of iron and of "temper" carbon (which is graphite in round nodules instead of in flakes as in grey iron). This type of structure yields some very desirable physical properties.

Physical Properties

Possibly the outstanding property of blackheart malleable cast iron is its ability to resist shock, in addition to good ductility, tensile strength, and ease of machinability. These properties, along with its durability, have led to wide usage in the motor-car, agricultural implement, railroad fittings, and electrical industries.

A property of this material which should merit consideration is the fair resistance (for a ferrous metal) offered to corrosion, especially atmospheric. When protected by a hot-dip galvanised coating, it possesses decidedly superior corrosion-resistant qualities under a variety of conditions. The addition of copper in amounts up to 2.0 per cent. has been found beneficial in increasing the resistance to certain kinds of corrosion, without affecting the other properties to any extent.

Blackheart malleable cast iron has been in use for so many years that its mechanical properties are well known. These are covered by specifications issued by the American Society for Testing Materials, A 47-33, Grades 32510 and 35018, for malleable iron castings for railroad, motor vehicle, agricultural implements, and general machinery purposes. These specifications apply to iron made by air-furnace, open-hearth, or electric furnace processes. Specification A 197-39 covers cupola malleable iron, an iron used especially for pipe fittings. Physical properties outlined in these specifications are given below. For comparison purposes, similar values listed in the British Standard Specification are also shown on Table II.

TABLE II.—*Comparative Standards for Blackheart Malleable Irons.*

	A.S.T.M. A.47/33		A 197–39	B.S. 310–1927
	Grade No. 32510	Grade No. 35018	—	(Amnd'd Feb. 1942)
Tensile strength (min.) tons per sq. in.	22.3	23.6	17.9	20.0
Yield point (min.) tons per sq. in. ..	14.5	15.6	13.4	—
Elongation in 2 in., minimum per cent.	10	18	5	75
Bend test, deg. ..	—	—	—	90

The A.S.T.M. Specification A 47-33 has been adopted as a standard specification for malleable iron castings by the Society of Automotive Engineers (S.A.E.), and is endorsed by the American Foundrymen's Association. Blackheart malleable cast iron made to meet A.S.T.M. Specification A 47-33 will very probably have the following physical and mechanical properties:

Specific Gravity 7.15-7.45

Coefficient of Thermal Expansion—
- Per degree Centrigrade 0.000012
- Per degree Fahrenheit 0.0000066

Reduction of Area (not usually determined, since the specimens are tested in the unmachined condition and measurement of reduction of area is hard to make in this state. Furthermore, malleable iron stretches throughout the whole gauge length of the tensile bar with but little local "necking"):

On carefully prepared cylindrical specimens, reductions of area of from 18 to 23 per cent. have been recorded.

Modulus of elasticity in tension, in tons per sq. in. 11,200

Ultimate shearing strength, tons per sq. in. 21.4

High yield point in shear, tons per sq. in. 10.2

Modulus of elasticity in shear, tons per sq. in. 5,600

Modulus of rupture in torsion, tons per sq. in. 25.9

Brinell hardness 110-145

Impact values for malleable iron are seldom determined, but the following results have been reported:—

Charpy, foot pounds	7.75
Izod, foot pounds	9.3
Fatigue endurance limit, tons per sq. in.	11.2 to 11.8
Endurance ratio (endurance limit/ultimate strength)	...0.43-0.54

If malleable iron is heated above 760 deg. C. the carbon redissolves and the character of the material changes. Hence, the use of malleable iron for temperatures over 650 to 700 deg. C. should be avoided.

Since the physical properties of malleable iron are dependent on heat-treatment (annealing), the heat of fusion welding will change the structure and physical properties permanently unless the temperature is kept low (under 760 deg. C.). If the casting may be annealed after welding, both arc and gas welding may be used, and various methods may be employed. Where annealing after welding is not feasible, such as in repairing broken parts, bronze-welding may be done, provided the temperature is controlled. It is reported that the tensile strength and elongation of good arc, gas and resistance welds in malleable iron, which have been annealed after welding, are approximately 90 per cent. of those of the original malleable iron.

Industrial Uses of Malleable Castings

Where strength, ductility, machinability, and resistance to shock are important considerations, malleable iron castings find a wide field of industrial application. Some of the industrial uses of blackheart malleable iron castings are as follow:—

Agricultural Implements—Ploughs, tractors, harrows, reapers, mowers, binders, cultivators, rakes, spreaders, pumps, feed grinders and cutters, hand implements, wagon parts, vegetable washer and binder, hay mowers, hemp harvesters, cotton gin machinery, beet diggers, potato diggers, pea binders, ensilage cutters and loaders, corn huskers, corn pickers, combines, threshers, grain drills, hay presses, hay loaders, hay tedders, manure spreaders, fence post parts and fittings, poultry equipment, dairy equipment, barn equipment, ferrules, clevises.

Automotive—Parts for frame, wheels, spring assembly, brakes, motor transmission, axles, steering gear assembly, body, accessories, etc., including: *Passenger cars*—Differential carriers, differential cases, bearing caps, spring hangers, spring seats, spring seat caps, shock absorber brackets, shock absorber housings, shock absorber liners, brake and clutch pedals, pedal brackets, pedal and master cylinder brackets, transmission brake supports, bearing retainers, steering gear cases, steering gear brackets, steering post brackets, steering post lock bodies, spare tyre lock bodies, adjusting nuts, hubs, combination hub and brake drums, motor supports, generator and fan supports, vibration dampener plates, bumper brackets, radiator inlets and outlets, exhaust pipe flanges, body brackets, shifter forks and spare wheel brackets. *Trucks*—The parts listed under passenger cars are similarly used in truck construction. In addition, many rear axle housings and dual wheel hubs are of malleable iron.

Automotive and Garage Equipment—Jacks for passenger cars, heavy-duty garage hydraulic jacks, trailer supports and tyre inspection devices.

Boilers, Tanks and Engines—Boilers, tanks, fittings, engine parts, outboard motors, Diesel engines.

Building Equipment—Hardware for windows, doors, garage equipment, awning hardware.

Conveyor and Elevator Equipment—Chains, buckets, pulleys, rollers, cranes, hoists, fittings.

Electrical and Industrial Power Equipment—Motor and generator parts, pumps, stokers, electric locomotives and tractors, steam specialities, outlet and switch boxes.

Hardware and Small Tools—Pneumatic and portable tools, miscellaneous tools, saddlery, hardware, table and kitchen utensils.

Household Appliances—Stoves, sewing machines, refrigerators, washing and ironing machines, vacuum cleaners, dishwashing machines, oil burners, electric fans and toasters, radios.

Machine Tools—Lathes, planers, shapers, grinders, screw machines, gear cutters, drills.

Machinery for Special Uses—Textile, cement, rubber, shoe, mining and quarrying, grinding, forging, foundry, bakery, woodworking, bottling, ice, laundry industries.

Marine Equipment—Anchors, chains, capstans, fastenings, towing bits, hardware.

Metal Furniture and Fixtures—Stoves, beds, desks, filing cabinets, shelving, hotel supply equipment.

Municipal, State and Public Service—Bridge and Street—Guard railings, drain scuppers, catch basin and manhole covers, street lamp standards, curb armour and traffic markers. *Highway Construction*—Guard rail parts, including brackets, turn-buckles, anchors; road building parts, including joint supports, drainage inlets and traffic markers. *Transmission Line Equipment*—High-voltage insulator caps, guy-line anchors, electric railway fittings.

Pipe Fittings and Plumbing Supplies—Elbows, unions, reducers, flanges, valves, bolts, nuts.

Railroads—Wide variety of parts for construction of locomotives, freight and passenger cars, guard rails, track accessories, etc., including: *Locomotive Parts*—Oil cups, cab ventilator castings, cab storm window parts, cylinder cocks, smoke box lug and hinge, hand rail column, grease cup bushing, grease plug, reverse lever handle, signal, air, steam and tank hose clamps, valve handles, flexible steam connectors. *Passenger Car Parts*—Signal lamp and flag brackets, uncoupling lever guide, draft sill filler block, buffer plate, lid for journal box, buffer stem brackets, foot plate for vestibule, threshold plate for side door, queen post, flexible steam heat connectors, air and signal hose clamps, side bearings, window hardware. *Freight Car Parts*—Uncoupling lever brackets, journal bearing wedges, journal box lid, draft lugs, push pole pockets, door fixture castings, centre plates, striking plates, door post pockets, brake shaft bearings, coupler car-

riers, card holders, ownership and brake diagram badge plates, drop bottom gondola operating mechanism parts, hinge butts, brake beam parts, brake beam support parts, draft gear parts, side bearing braces, hopper car door operating mechanism castings, brake wheels, power brake castings. —*Tank Car Parts*—Dome covers and rings, outlet valves, safety valve flanges, safety valve housings, tank band anchors, body side bearings, slabbing castings, card holders, valve hand wheels, pipe brackets. *Refrigerator Car Parts*—Ice rack supports, door hinges, hatch door hinges, drain castings. *Track and Switch Castings*—Rail braces, adjustable rail braces, guard rail braces, combined rail brace and tie plate, special tie plates, filler blocks, rail anchors, gauge rod ends, track gauge ends, switch stands, bell cranks, turnbuckles, clevises, pipe connnectors, pipe supports.

Road and Contractor's Machinery—Rollers, excavators, cranes, hoists, tractors, graders, mixers, pavers.

Toys and Specialities—Sleds, wagons, automobiles, bicycles, carriages, gun parts.

In view of its good combination of strength, ductility, and corrosion resistance, blackheart malleable cast iron should be a satisfactory substitute material in many applications. In considering it as a substitute, attention should be given to the properties of the iron and the properties of the metal to be replaced. In any substitution, however, it should not be overlooked that malleable iron is magnetic and, consequently, cannot be used in applications where nonmagnetic properties are required.

PEARLITIC MALLEABLE CAST IRON

During the past few years, modifications of the normal blackheart malleable irons have come into increasing prominence in industry. While these materials have characteristics essentially different from those of normal blackheart malleable iron, they are made by practically the same methods. Such irons are commercially known as "pearlitic malleables," a name which, while not rigidly justifiable metallographically, seems to be the commercially most useful generic name, as it avoids the cumbersome nomenclature required for strict scientific precision.

Pearlitic malleable cast iron is distinguished from the blackheart malleable cast iron by the character of the matrix. This distinction is due to the fact that pearlitic malleable iron contains some carbon in the combined form, whereas blackheart malleable iron contains, generally, only a minute quantity of combined carbon. The pearlitic malleables differ in properties as their matrices differ. The significant amounts of combined carbon in pearlitic malleable make it stronger, harder, and less ductile than standard blackheart malleable iron.

The pearlitic malleables may be classified into two major divisions:—(1) Metal produced by interrupting graphitisation before completion; and (2) metal produced by reheating completely graphitised alloys. Division (1) can be sub-divided into two classes: (A) Metal having a composition similar to that of blackheart malleable iron, in which the retention of combined carbon is due to a shortening of the annealing cycle; and (B) metal to which various retarding elements have been added to secure a retention of combined carbon even with reasonably extensive heat-treatment. Division (2) contains in practice alloys of Class A only. If one is to completely graphitise the metal, there is no point in retarding the operation.

Pearlitic malleable cast irons can be classified as those having completely pearlitic backgrounds for the temper carbon and those in which the temper carbon background is a mixture of pearlite and ferrite. In each group there would be sub-divisions depending upon the condition of the pearlite (i.e., coarsely laminated, sorbitised or spheroidised). A number of the commercial pearlitic malleables are of the spheroidised type.

By regulating the process, materials can be made with varying amounts of desired combined carbon, but the amounts contained usually are from 0.30 to 0.80 per cent. By variations in the heat-treating methods, the form and amount of carbides may be varied. It becomes possible, therefore, to produce different types of pearlitic malleables with physical properties that vary from those of standard (blackheart) malleable to those with a tensile strength of about 56 tons per sq. in. and an elongation of 2 to 3 per cent.

General Properties

Pearlitic malleable cast iron is stronger and less ductile than normal blackheart malleable iron and has a higher elastic ratio. It machines somewhat less readily than normal blackheart malleable cast iron, but as compared with steel forgings and steel castings it may be machined in substantially less time, with greater tool life. The indentation hardness is higher than that of straight malleable. The fatigue ratio is near the expected value of 50 per cent. Because of the possibility of variations in heat-treatment, the possible range of physical properties is very broad (tensile, 20 to 56 tons per sq. in.). Generally, the tensile strength and elongation vary inversely, although this is qualified by the fact that ductility is more dependent on the form of the combined carbon and its distribution in the matrix than is the tensile strength. There is a correlation between tensile strength, combined carbon content, and Brinell hardness. Because of the combined carbon content, pearlitic malleable cast iron can be successfully selective-hardened. Care must be taken, however, if an increase in combined carbon, brought about by solution of temper carbon, is to be avoided.

Most of the producers of pearlitic malleable cast iron claim superior wear characteristics for the material, and performance in commercial applications seems to bear out their claims. The high resistance to wear includes both frictional and abrasive or galling applications.

Specifications and References

Committee A-7, on Malleable Iron Castings, of the American Society for Testing Materials has been considering pearlitic malleable iron castings and has issued a tentative specification, A 220-39T, to cover such material. Information is given regarding the classification, description, size of test specimens, etc., but as yet no values for tensile and yield strengths, nor for elongation, are included.

Due to the comparatively recent commercial development of pearlitic malleable iron castings, there are but few references thereto in the literature. Possibly the earliest published information was given by E. Touceda at a meeting of the American Society of Mechanical Engineers in 1919. In 1923, E. K. Smith summarised much data in a Paper, "Hardened and Tempered Malleable Castings," at the American Foundrymen's Association convention at Cleveland. Over the next few years most of the information on pearlitic malleable irons is to be found in patent papers; until 1936, when the American Society for Testing Materials held a Symposium on this subject. The report of this meeting contributed some very valuable metallurgical information on this subject. In a Paper given by Dr. C. H. Lorig at the 1940 annual meeting of this society, considerable data on various pearlitic malleable irons were given from information supplied by different manufacturers. A bulletin by D. L. Boyes, published in 1941, gives much information on the properties and uses of present-day commercial pearlitic malleable irons. (An exhaustive Paper by E. Joseph on ArmaSteel, one of the principal American types of pearlitic malleable, was read at the 1942 Annual Conference of the Institute of British Foundrymen, and was reprinted in the 1941-42 Proceedings and in the FOUNDRY TRADE JOURNAL for August 20 and 27 and September 3, 1942.)

Commercial Pearlitic Malleable Cast Irons

There are approximately 15 distinct pearlitic malleables in common use, some of which differ in manner of production rather than in properties. Among the better-known commercial trade names under which pearlitic malleable-iron castings are sold are:—

Promal—Link-Belt Company, Indianapolis, Indiana.
ArmaSteel—Saginaw Malleable Division, General Motors Corporation, Saginaw, Michigan.
Z-Metal—Ferrous Metals Corporation, New York, with seven licensees authorised to manufacture.
Belmalloy—Belle City Malleable Iron Company, Racine, Wisconsin.
Mallix—National Malleable and Steel Castings Company, Cleveland, Ohio.
Pearlitic Malleable Meehanite—licensed by Meehanite Metal Corporation, Pittsburgh, Pa.

Promal

Promal, a product of the Link-Belt Company, Indianapolis, Indiana, was one of the first pearlitic malleables in the commercial field. Its general physical properties are given as follows:—

Tensile strength	31.2 to 33.5 tons per sq. in.
Yield point	22.3 to 24.6 tons per sq. in.
Fatigue strength	15.6 tons.
Elongation	14 to 10 per cent.
Modulus of elasticity ...	11,650 tons.
Brinell hardness	170 to 190.
Specific gravity	7.35.
Coefficient of thermal expansion	0.000019.

The amount of carbon recombined is between 0.30 and 0.40; by increasing the amount, the tensile strength can be increased to 40 tons per sq. in., but with reduced elongation. By suitable alloy additions, the tensile strength can be raised to over 44.6 tons per sq. in., with proportionately raised yield point and Brinell hardness and with an elongation of 10 to 14 per cent. Probably the largest use of Promal is in cast elevating, conveying, and power transmitting chains, but it is also used in a great variety of parts where higher strength and good wearing characteristics are required, as in gears for chain hoists, stokers, lawn mowers, road graders, and other machines, and parts for power shovels, lawn mowers, and farm implements. Some of these parts were formerly made from either forgings or steel castings.

ArmaSteel

ArmaSteel (arrested malleablised steel), a product of the Saginaw Malleable Iron Division of General Motors Corporation, is of standard duplexed blackheart malleable composition, with retention of the desired amount of combined carbon achieved by interrupting graphitisation before completion. The combined carbon is present as a sorbitic structure and also in the form of minute spheroids of iron carbide imbedded in the matrix of the iron. When heat-treated, martensite, or some other form of decomposition product of austenite, will be produced.

ArmaSteel possesses excellent wear characteristics. It has been successfully adapted to selective hardening either by the Tocco process, the flame-hardening process, or by immersion in lead or salt bath. The physical properties of ArmaSteel, as made for different applications, are given as follows:

Ultimate tensile strength ...	29 to 40 tons per sq. in.
Yield point	20.1 to 36.6 tons per sq. in.
Elongation	6 to 3 per cent.
Brinell hardness	143 to 241.

It has been used in the replacement of steel forgings, for camshafts and rocker arms in automotive and Diesel engines, and has given remarkable service when used for pistons for Diesel engines. It is reported that development work is in progress on an alloyed ArmaSteel to be used for parts requiring higher strength and greater hardenability than possessed by regular ArmaSteel.

American Malleable Irons

Z-Metal

Z-Metal manufacture is covered by a series of patents, dealing with equipment, process and product, which are owned and licensed for use by the Ferrous Metal Corporation, of New York City. The principle involved in the production of pearlitic malleable is the use of retarding elements added to the molten metal either in the melting furnace or in the pouring ladle. In common with other types of pearlitic malleable, Z-Metal derives its physical properties from the retention of combined carbon and the physical condition of this combined carbon (spheroidised). By adjustment of the heat-treatment and by variation of the alloy content, a wide variation of physical properties can be obtained. The physical properties of Z-Metal are reported as follows:—

Tensile strength	31 to 40 tons per sq. in.
Yield point	21.4 to 26.8 tons per sq. in.
Fatigue limit (average) ...	16.7 tons per sq. in.
Elongation	18 to 8 per cent.
Brinell hardness	155 to 225.
Modulus of elasticity ...	11,650 to 12,900 tons.

As in the case of other pearlitic malleables, Z-Metal is susceptible to surface hardening. When selective hardening is to be performed, the material is made with an addition of molybdenum to the composition. Z-Metal has been used to replace normal malleable, steel forgings, steel castings, and other types of ferrous materials. It is reported as being used in many applications in railway, automotive, fittings, machine parts and tool industries, and in ordnance material such as pistol and gun parts and shell castings.

Other Trade Names

The other trade-named pearlitic malleables have physical and mechanical properties that conform closely to those previously mentioned and are used in similar applications. It is also reported that pearlitic malleable iron castings have been used in the replacement of some non-ferrous materials.

Summary

The advantages possessed by pearlitic malleable in strength, selective hardening, and wear and abrasion resistance have been shown. It also possesses reasonably good machinability (not so good as blackheart malleable, but better than steel forgings or steel castings of the same Brinell hardness). It may also be machined to a fine finish and will take a high polish. It has proved superior to many competitive materials in damping capacity. Its resistance to many corrosive media is quite good, and may be further improved by the addition of small amounts of copper to its composition. With all of these properties are included the advantages inherent in casting rather than forging a part. Parts requiring cavities may have these cored out and cast practically to shape, with a resultant saving of material and also a reduction of the amount of machining necessary to obtain the necessary dimensions. Parts of intricate design also can usually be more successfully cast than forged.

Limitation of the uses of pearlitic malleable iron is due to the difficulty that is encountered in producing castings which have section-thickness exceeding one inch, and also because no satisfactory welding technique has been developed. However, there are many applications where these limitations do not interfere with its efficient use.

Pearlitic malleable iron would seem to have a large potential field, due to wide variation of physical properties possible by heat-treatment. It can be produced in the air furnace as well as in the electric furnace. It is being sold under several trade names with some slight variation in method of manufacture, and also with some variation in the microstructure accomplished by the heat-treatment. It is felt that the possibilities shown in the properties of pearlitic malleable iron are not sufficiently known by those who might use it advantageously, either as a replacement for parts made from steel forgings or as a substitution in some applications for certain non-ferrous materials.

PRODUCTION OF TRUNCATED PISTONS

(*Concluded from page* 247.)

viously tried methods gave rise to an infinite variety of internal and structural defects which only became visible after being partly machined.

This method of production is now being standardised for all the various sizes of this type of piston. Special boxes and sets of Meehanite metal patterns are now in the course of preparation which will enable sound pistons to be produced two in a box from moulding machines. In reviewing these experiences with truncated pistons, it should not be supposed that the relevant matters of sand and metal were neglected in any way. In point of fact, considerable time was expended in determining the most suitable sands for moulds and cores.

As to the metal used, various Meehanite processes were used in efforts to secure some particular characteristics such as greater fluidity, closer metal, shorter freezing range, etc. The original recommendation has now, however, been reverted to, and pistons are now produced exclusively in Process G.D. metal, over which the utmost control is exercised in order to avoid porosity and shrinkage troubles.

Large Castings for Heavy Guns.—Steel castings comprise a large part of the barbette carriages and stands required to support the barrel of 16-in. guns being built for coast defence purposes in the United States. The principal supporting members of barrel and cradle are two cast-steel side frames weighing about 20 tons apiece.

PRODUCTION OF TRUNCATED PISTONS

Description of Moulding and Coring Practice

By A. H. CLIMAS

The production of a regular and not inconsiderable output of pistons for use in two-stage air compressors has presented an interesting problem and perhaps a far greater problem than may appear evident at first sight. It is proposed to recount some experiences because of the unexpected difficulties which arose in this connection from an apparently straightforward job. Before proceeding further it would be well to consider the nature of the piston and its requirements, in some detail.

Fig. 1 illustrates the type of piston under consideration. It is a double acting piston used in two-stage compressors having low pressure and high pressure sides. The piston is required to compress air at pressures up to 200 lbs. per sq. in. Freedom from porosity at any point is essential and any surface defects of the most minute nature will also suffice to cause rejection, because of the danger of causing

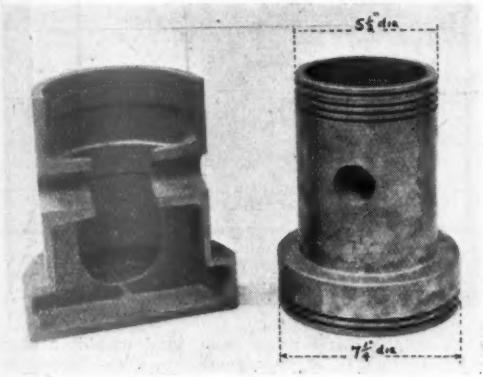


FIG. 1.—TYPE OF PISTON.

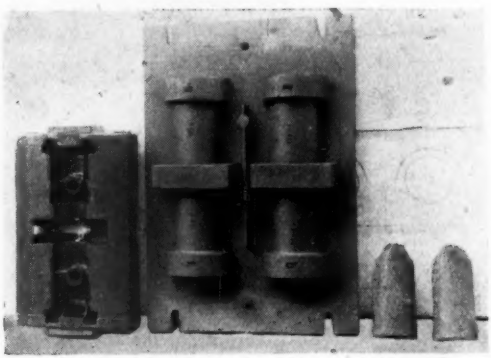
damage to the cylinder walls. A very severe standard of inspection is enforced on this work and this also takes into consideration shape and machining tolerances.

From the foundry point of view the first problem which must be considered is how to mould the piston to yield good results with a steady output. Moulding is somewhat complicated by the bulbous core, which precludes the possibility of casting on end, in the manner usually adopted for this type of work and involving dropping the core in from the top. The pistons have been designed with an even thickness of metal on the walls and skirt so far as this is possible, but where ring grooves and gudgeon holes are cut, relatively thicker sections and bosses inevitably appear and these possible places where hot spots may occur are accentuated by the stiffening webs which run to the walls of the casting and support the bosses.

Initial Attempt

Fully conscious of the problems which would have to be met but perhaps without being aware of their magnitude, the first experimental pattern layout was prepared. It was decided to cast the pistons in an horizontal position four in a box, thus balancing the core (Fig. 2) with an adequate core print and the complete runner system incorporated in the core box (Fig. 2A.) Gating was effected at the bottom of the mould, and the dirt trap was also incorporated.

The patterns were made in halves and mounted on



A. B.

FIG. 2.—BALANCING OF CORES, WITH (A) CORE PRINT AND COMPLETE RUNNER SYSTEM INCORPORATED IN COREBOX; AND (B) RISERS OF STANDARD MEEHANITE DESIGN.

a plate. Cores were tested with ring gauges and the moulder was also provided with gauges to ensure accurate coring. Green sand moulds were used in this instance. The yield of good castings from this method of casting was very low. Shrinkage and porosity showed up when the ring grooves and gudgeon holes were being machined. Porosity did not show up consistently in all castings, sometimes it would appear on skirt of piston and also underneath where webs were connected to walls. This

Production of Truncated Pistons

complicated the procedure somewhat but it was decided to exhaust the possibilities of casting in this position seeing that equipment had been prepared, the first modification carried out consisted of substituting the small whistlers on the low pressure end of the piston with a fairly heavy riser of conventional foundry shape. Upon rough machining, however, porosity showed up to an even greater extent.

It is interesting to note that later when risers of standard Meehanite design were used (Fig. 2B) the defectives were considerably reduced and somewhat better results were obtained but the percentage of good castings, however, were still much too low. The cores were only blackened where pasted together and on the L.P. end of the core.

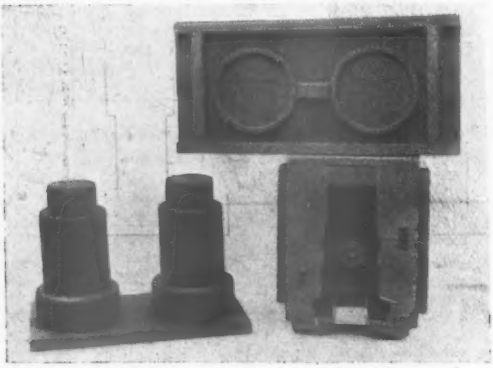


FIG. 3.—PATTERN LAYOUT, WITH TWO-PART LARGE COVERING CORE, RIGHT ABOVE.

First Vertical Method

Having exhausted the possibilities of casting these pistons on their sides, it was next decided to make these in an upright position. The pattern layout of the method adopted is shown in Fig. 3. The patterns were four in number and were mounted on a board for machine moulding. The core was stood upright in a very generous print in the single box part used. A two-part large covering core was used to cover the mould (Fig. 3). In this core a runner bar, ring runners and pencil gates are incorporated, the dirt trap being rammed up in the top box.

The gates were placed uniformly round the top of the casting and as far away from the gudgeon hole bosses as possible to prevent splashing. The cores were generously vented and also the moulds, to allow the easy escape of gases, but this method proved another disappointment. Gas was continually being trapped on the crown of the piston. Extensive experiments were carried out by adjusting the size of the pencil gates and the dimensions of the runners, without any marked

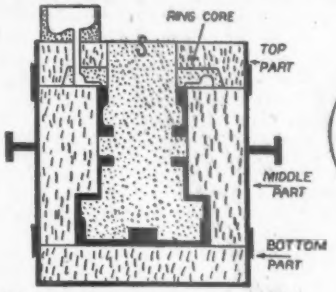


FIG. 4.—CORE SUSPENDED FROM TOP OF BOX.

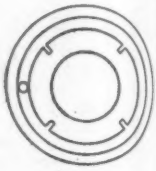


FIG. 5.—RING CORE USED.

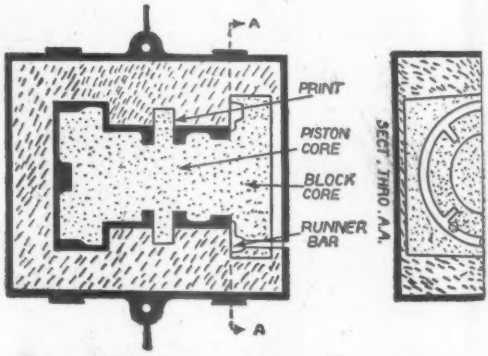


FIG. 6.—MOULDING AND CORING UP ON THE FLAT.

success, and still using green sand moulds a certain number of defectives from loose sand were also rejected.

Using Dry Sand Reduces Wasters

Having decided that only very moderate success could be achieved by using green sand moulds, a third trial method of production was embarked upon, in which concentration was to be made upon producing perfectly sound castings without regard to quantity production. To this end the principle of progressive solidification was employed. Dry sand moulds were used, and in order to facilitate the exit of gas from the core, this was suspended from the top part of the box as illustrated in Fig 4. Fig. 5 shows ring core as used.

The mould assembly was carried out in the following manner. Ram up the bottom part, and on this place a distance piece in the form of a ring or two

strips of wood to support the core at the correct height in the mould. Place the core upon this distance gauge, then pass over the middle part and the top part which contains the print for holding the core in position, and of course contains the ring core in which runners and gates are formed. The next step was to clamp the top and middle parts together and secure the main core at the correct height, by means of a hook and bars on top of the mould. When the core was thus secured, the top and middle parts were then lifted, the gauge or gauges removed and the whole box reassembled using master pins and clamped together, and with the addition of a correct basin on the mould was ready for casting.

This method showed a great improvement regarding porosity defects, as was reasonably to be expected in view of the greater amount of work put into the job and the safer moulding principles employed.

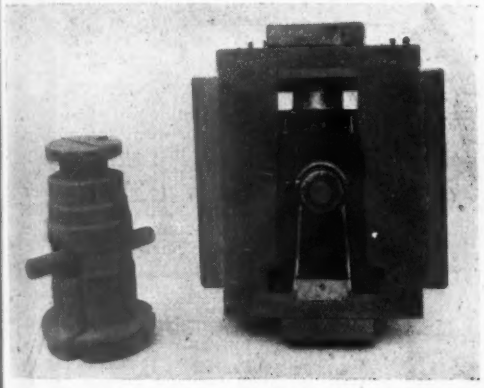


FIG. 7.—DETAILS OF CORE WITH COREBOX ON RIGHT.

Traces of porosity were, however, still present in the gudgeon hole bosses. The main difficulty with this method of production was the difficulty of centring the core accurately, a slight variation with the hook and bar on top of mould would throw the core out of centre at bottom of mould and consequently walls would be very thin; this was actually productive of the major portion of the scrap produced.

The Final and Successful Method

The third production method described above gave effective proof of the possibility of securing sound pistons if the objections of offset cores could be eliminated and it was decided to develop the great possibilities in a fourth trial. To this end the patterns were again split lengthways and put on a pattern plate, this time using only a single pattern, and by extending the core through the gudgeon pin holes into prints on either side of pattern it was then possible to mould and core up on the flat (Fig. 6) and turn up the whole box on end for casting.

The moulder was thus able to see the accurate coring of the mould and given every gauge essential this eliminated any possibility of the core being out of centre either way. A large square print on top of the core was intended to take the weight of the core, and this again contained the complete gating system, downgate, ring runner and ingates. The additional prints through the gudgeon holes of course were of considerable assistance in securing core location. This method of production proved very satisfactory, except that it was found to be a very difficult operation to close the mould without causing a crush with the large square print of the core. Attempts to relieve this were made with an adequate amount of taper, but this resulted in large patches of porosity on the crown of the piston, the additional taper had also produced a considerable "flash" gate around one side of the piston.

The core print was again altered and in place of the large block core a round one was substituted which considerably reduced the possibility of a

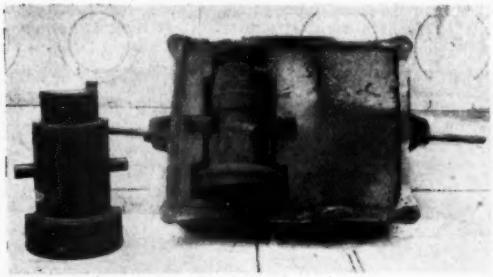


FIG. 8.—CORED-UP MOULD WITH CORE IN POSITION FOR CASTING.

"crush." It was decided to let the prints through the gudgeon holes take the weight of the core and continue the stub of the core into a print of the same diameter, the length being sufficient to counterbalance the weight of the other end. The gating system this time is made around the outside of the core, details of which are shown in Fig. 7, with the core box on the right.

A general view of the cored up mould together with core in position for casting is given in Fig. 8. This method has proved very satisfactory and up to the present moment more than 80 per cent. of the castings so produced have passed through inspection. This figure is by far the greatest yield given by any method of production previously attempted and moreover when castings produced by this method pass foundry inspection it may safely be assumed that these will machine up perfectly, whereas the pre-

(*Concluded on page* 244.)

MACHINE CASTING ALUMINIUM INGOTS

A NEW FIELD OF DEVELOPMENT

Hitherto little has been done to develop the machine casting of ingots of non-ferrous metals. Some time back a machine of Swiss manufacture was introduced into this country, but its performance does not appear to have been such as to justify its adoption and so far as we are aware only one such machine was put into commission.

Recently a large aluminium combine commissioned Sheppard & Sons, Limited, of Bridgend, to design a machine for casting aluminium ingots, and, satisfied regarding the soundness of the design, they placed an order for three. The machine illustrated, which our representative inspected at the Bridgend works of the builders, was the first completed and has since been put into commission. The general construction will be understood from the line drawing, while the compact and robust design will also be evident.

The machine is 15-ft. centres on terminal shafts. The framework is fabricated of rolled steel angles and channels, very adequately braced in all directions to form a rigid structure. It is mounted upon wheels so as to provide a traverse along a horizontal track through hand-wheel operation.

The casting belt carries 54 moulds, the upper edges of which are machined, while on the underside are machined pads which are secured by bolts to the travelling chain. Asbestos pads are interposed between the machined pads on the moulds and the attachment on the links so as to insulate the latter, as far as possible, from the effects of the heated mould. Each mould is provided with a lip on the trailing edge, so that should a mould be inadvertently overfilled, the surplus metal will flow into the succeeding mould without the possibility of spillage.

The chain consists of two strands of links each having one thick and two thin links alternatively. Attachments are welded to the links for the reception of the moulds. Each joint pin is fitted with two machined cast-iron rollers which are provided with Tecalemit lubricating nipples. The trailing and driving shafts are fitted with cast-iron hexagonal sprockets, the driving sprocket being fitted with renewable teeth. The trailing shaft runs in heavy cast-iron tension blocks controlled by means of steel tension screws.

A patented device, in the form of a special spring, is embedded in each roller assembly to allow for unequal expansion between the mould and the spindle, so that all possibility of jamming is eliminated. The running angles for the rollers are provided with renewable wearing strips which are secured by counter-sunk bolts to the horizontal leg of the angles. The drive for the machine is at the discharge end, and consists of a 1½ h.p. four-speed motor controlled by means of a push-button-operated contactor starter fitted with isolating link and a four-way selector switch for speed selection. The motor is direct coupled to a David Brown worm reduction gear from which the first-motion shaft is driven by Renold chain which is totally enclosed and

(*Continued on page* 252.)

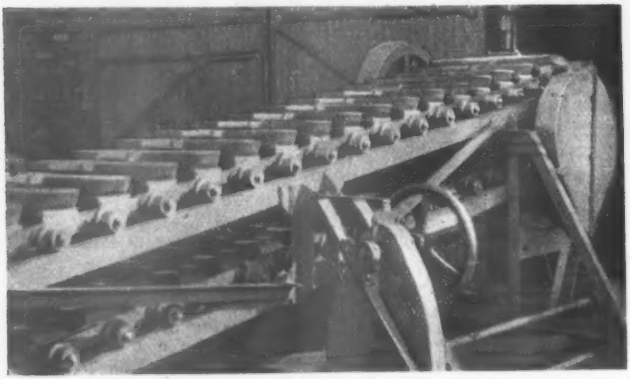


FIG. 1.—GENERAL VIEW OF MACHINE.

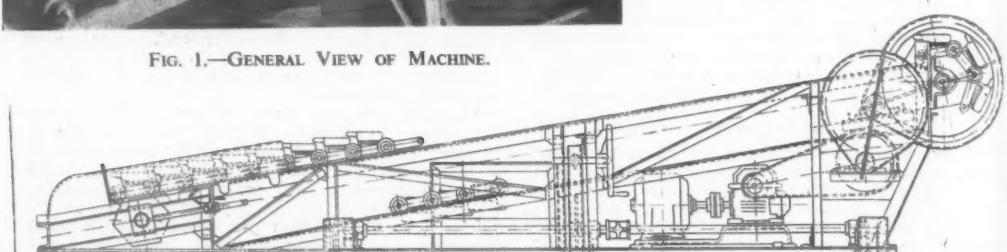


FIG. 2.—GENERAL ARRANGEMENT OF MACHINE FOR CASTING ALUMINIUM INGOTS.

X-RAY INSPECTION OF AIRCRAFT CASTINGS

REVIEW OF CURRENT AMERICAN PRACTICE

ROBERT KATZ, Assistant Radiologist, Army Air Forces Material Centre, Wright Field, contributes to "Metal Progress" a survey of the U.S. Army Air Forces' requirements for the X-ray inspection of certain structural castings used in aircraft. He points out that towards the end of 1941 it became imperative that general standards for the acceptance of aircraft castings be established. At that time the commercial standards for the acceptance or rejection were largely intangible; castings rejected by one radiographic laboratory were later accepted by another. As a check on the validity of commercial X-ray inspection, rejected castings were subjected to breakdown or tensile tests conducted upon specimens machined from castings, and many were found to have strengths considerably in excess of design or specification values. Pressure of increased aircraft production made such a waste of material intolerable.

It thus became necessary to establish an inspection procedure which would insure that: (1) No casting which might fail would find its way into an airplane structure; (2) a minimum number of usable parts would be discarded by unnecessarily rigid inspection standards, and (3) the inspection procedure be as economical of man-power and materials as was consistent with the first two aims.

To achieve these ends, a procedure for the X-ray examination of structural castings which attempted to resolve these principles was adopted by the Army Air Forces in February, 1942. The author outlines the testing procedure with some representative radiographs, principally of sand and gravity die castings of aluminium or magnesium alloys used in airplanes. Castings for use in hydraulic systems need not be X-rayed if they are hydrostatically tested unless sections of these castings are also subject to structural loads, whereupon such sections are subject to the same requirements as structural castings.

Allowable Stress

In the design an allowable stress is permitted of half the minimum specified ultimate strength, as determined on separately cast test bars. Castings may be designed for no X-ray inspection provided that ultimate design loads will not produce stresses in excess of 20 per cent. of the allowable stress (10 per cent. of minimum test-bar strength) and such castings are known as Class B castings. Castings designed so that the ultimate design loads produce stresses between 20 and 100 per cent. of the allowable stress are called Class A castings, and must be radiographically examined and statically tested as outlined below.

Test Lot

Once preliminary design and foundry development have been completed, and production pattern equipment has been prepared, a test lot, consisting of the first 100 castings of the first production run of each Class A design, must be 100 per cent. X-ray inspected, with special reference to stressed sections. The three worst castings of this test lot, as graded by the radiographs, are then machined and tested so as to simulate the loading of the castings as installed in the airplane. Radiographs of the three test castings become acceptance standards for all other castings of the same design, if the weakest casting withstands a test load of 1.5 times the design load (1.25 times for centrifugal steel castings).

Should the test castings prove too weak, sounder castings may be selected from the test lot until satisfactory radiographic standards are obtained. The Army inspector may reduce the size of the test lot for complicated castings which are expensive to radiograph. Where fewer than 100 castings are required of a particular Class A design, the entire lot of castings constitutes the test lot, but only one need be statically tested.

In the course of production, casting quality may vary sufficiently from the test lot so that a revision of the X-ray standards is desirable. The contractor may revise these standards at his option by repeating the X-ray and static test procedure upon any group consisting of 100 consecutive production castings.

Production Runs

Lots subsequent to the test lot are radiographically inspected on a percentage basis, according to the ratio of test loads and design loads of the weakest of the test castings. Where this ratio lies between 1.5 and 3.0 (1.25 and 3.0 for centrifugal steel castings), all castings in the order or production run are given 25 per cent. inspection and are called Class A-1. Class A-2 castings are those in which the ratio of test to design loads lies between 3 and 10, and receive 10 per cent. inspection. Where the ratio is greater than 10. castings receive no X-ray inspection and are called Class A-3. When 1 per cent. of the original sampling (the 25 per cent. for Class A-1, or the 10 per cent. for Class A-2) is found inferior to the standards, 100 per cent. inspection of the balance of the lot may be required.

Sub-standard A-1 castings are rejected, but sub-standard A-2 castings are placed in salvage. Castings whose defects cannot be judged from the standard radiographs are similarly placed in salvage. Castings which receive no X-ray inspection are subject to visual inspection.

In addition to the requirements of static test, no Class A casting is acceptable which contains defects of a localised, stress raising type. Thus cracks, cold shuts, misruns, shrinkage voids, are automatic cause for rejection. Defects of a general type which do not act as stress raisers are considered undesirable, but are judged solely on the basis of the static test simulating the working loads on the complete part, as previously outlined. Such defects include gas porosity, blowholes, segregation, microshrinkage, dross and sand inclusions and mottling. Defects of a general type which are so aligned as to cause stress concentration are immediate cause for rejection.

X-Ray Inspection of Castings

Certification of Laboratories

The commercial radiography of Army aircraft castings has been restricted to an approved list of certified laboratories. Certification is set up on the basis of a simple test which requires a laboratory to prepare radiographs of a set of six castings equal to radiographs previously prepared at Wright Field. The required positioning is specified so that direct comparison of the quality of the X-ray films can be made. At the moment, about 40 laboratories scattered throughout the United States have been approved. A laboratory failing the first test will be re-tested upon application. Certification may be withdrawn when radiography in production fails to meet Army Air Forces requirements. Thus, each production radiograph must bear the clearly defined image of the applicable penetrometer sensitive gauge.

Certification simply permits an organisation to take X-ray pictures, but does not authorise the laboratory to accept or reject castings. Responsibility for structural castings, as well as for all parts of the aircraft, rests with the prime contractor (the aircraft manufacturer). The laboratory may not accept or reject castings for the prime contractor unless authorised in writing by the prime contractor, and a copy of the document furnished the Army inspector.

Terminology

Radiographic inspection has been much confused by the absence of a uniform, precisely defined terminology for the markings appearing on the radiograph. The same defect has been described as "gas porosity," "pinholing," "wormholing" and "pepper and salt porosity." The following definitions of various discontinuities have therefore been adopted:

Cracks are represented by darkened lines of variable width which are dendritic when caused by hot shortness, and are more nearly linear, or straight, and of more constant width when originating from residual stresses in solid metal.

Shrinkage.—Shrinkage cavities are represented by dendritic or filamentary dark regions of irregular dimensions and indistinct outline, and are caused by an insufficient supply of molten metal to feed the particular section.

Cold Shuts are represented by darkened areas of variable length and smooth outline which tend to be elongated and thin. They occur where the streams of molten metal have come together and have failed to weld together, so that the contact surfaces are oxidised. Cold shuts may generally be detected by visual examination.

Misruns appear as darkened areas of variable dimensions and smooth outlines where the molten metal has failed to fill the section. Misruns can always be seen by visual examination.

Gas porosity is generally found in aluminium alloy castings and is due to the presence of dissolved hydrogen in the molten metal. It appears as a well distributed peppering of round or irregular dark spots which tend to be elongated or curved in coarse grained castings. The porosity is distributed throughout the casting, the size of the holes varying with the gas content of the metal and the rate of solidification of the section.

Microshrinkage commonly appears in magnesium alloy castings, and occasionally in castings of other alloys, as dark feathery streaks, or as massive areas of fairly definite outline. *Blowholes* or gasholes usually appear as well defined spherical or rounded darkened areas. They are caused by trapped air mould or core gases, or water vapour and are random in occurrence, but tend to distribute on the cope side of a casting.

Dross Inclusions.—Dross or oxide inclusions appear as small darkened regions of irregular or indistinct outline, varying in intensity. These tend to be random in occurrence, but may become localised in the cope side of a casting. *Sand Inclusions* appear as grey spots of uneven granular texture with indistinct outline. They are random in occurrence, but tend to concentrate near the drag side of a casting.

Segregation of metallic inclusions (whether or not these properly constitute alloying elements) appear as well defined white spots or as mottled areas, regular or irregular in shape. *Mottling* appears as a pattern of alternate light and dark areas which tend to the size and shape of the macroscopic grains and is due to the difference in chemical composition between the grain and grain boundary material; most frequently found in aluminium alloy castings.

NEW COMPANIES

("Limited" is understood. Figures indicate capital. Names are of directors unless otherwise stated. Information compiled by Jordan & Sons, 116, Chancery Lane, London, W.C.2.)

Goyt Engineering Company, 296, Newbridge Lane, Stockport—£1,000. C., H., and J. Cotton and H. Pickford.

John Every (Lewes), Phœnix Iron Works, Lewes, Sussex—Founders, engineers, etc. £60,000. J. M. and J. F. Every.

Norris & Sabine—Engineers, founders, etc. £2,000. R. J. Norris, 82, The Park, Mitcham, Surrey, and D. E. Sabine.

Warroners (1943), Nile Terrace, Trafalgar Avenue, London, S.E.15—Metal and scrap merchants, etc. £2,000. E. F. and M. A. Williams and R. J. Rose.

C. H. Ores & Processing, 24, Grosvenor Gardens, London, S.W.1—Importers, exporters and processors of ores, etc. £1,000. C. Hirschler and E. A. Knight.

Foundry Services (Holdings), 285, Long Acre, Nechells, Birmingham, 7—To acquire shares in Foundry Services, Limited, and its subsidiaries. £20,000.

Charles Holmes (Halifax), L. & N.E.R. Goods Yard, North Bridge, Halifax—Metal and machinery brokers and merchants, etc. £5,000. C. Holmes and P. S. Green.

STANTON DALE

Refined PIG IRON

for High Duty

Castings by Morris Motors Limited.

Casting by Baker Perkins Limited

Castings by Ruston Hornsby Limited

Castings by Ruston Hornsby Limited

Casting by David Brown & Sons (Husdd.) Ltd.

Casting by Oxford & Cowley Ironworks Ltd.

THE STANTON IRONWORKS COMPANY LIMITED
NEAR NOTTINGHAM.

MACHINE CASTING ALUMINIUM INGOTS

(*Continued from page* 248.)

fitted with drip-feed lubricator. The drive from the first-motion countershaft to the headshaft is through double reduction gearing which is carried in steel casings.

It will be appreciated that the employment of a four-speed motor gives a wide latitude in casting speeds. In the machine under notice the highest speed gives a casting rate of 153 ingots per hour, while the second, third and lowest speeds give, respectively, 102, 76 and 51 ingots per hour.

Immediately the machine was delivered and erected, a test run was made under actual working conditions, approximately 30 cwts. of aluminium being cast. No trouble of any sort was experienced. The moulds, of course, got very hot, but the maximum sustained temperature had no detrimental effect whatsoever and every ingot was cleanly discharged.

It will be understood that with the machine under notice, mould cooling is purely atmospheric, while the discharge of the moulds is by gravity. Anticipating that the above conditions may not meet all requirements, the builders of the machine have designed a very effective system of mould cooling which employs air, water, or both. They have also designed a system of forcible automatic ingot discharge to overcome any tendency of an alloy to hold the mould. This last, however, would certainly not be necessary where the moulds are cooled by water, as coating of the moulds could be effected through the cooling water. Obviously the centre distances and the shape of the moulds are details which will be determined by circumstances; the machine therefore would seem to have considerable possibilities for the casting of all non-ferrous metals which are required in ingot form.

However, if the machine is to be fully employed at a commercial speed throughout the working day, artificial means of cooling the moulds will be necessary; otherwise the heat imparted by the molten metal will build up, the radiating surfaces being insufficient to dissipate it.

Iron Phosphorus Alloys.—A series of iron alloys, virtually free from carbon, silicon and manganese, with phosphorus ranging from 0.012 to 0.86 per cent., showed that the critical composition was 0.46 per cent. This work, carried out by Mr. James K. Stanley, of the Westinghouse Electric & Manufacturing Company, of Pittsburgh, was detailed in "The Iron Age." At this critical percentage the tensile strength, which increases rapidly from 16 to 24 tons per sq. in., begins to fall, whilst the corresponding increase in the yield strength becomes less pronounced. The elongation, however, reaches its maximum of 40 per cent. at 0.24 per cent. phosphorus, and diminishes rapidly until at 0.65 per cent., only 2.5 per cent. being registered. The Vickers hardness increased from 72 with the pure iron to 183 at 0.45 per cent. phosphorus, after which but little variation was noted.

PARLIAMENTARY NOTES

Surplus Goods and Factories

MR. DALTON, President of the Board of Trade, replying to a question, said it had been decided that the disposal by the Government of surplus goods and factories after the war should be carried out in a large number of instances through the agency of the department mainly concerned with the supply of the goods during the war. The Board of Trade, through its factory and storage control, would co-ordinate the disposal of all surplus Government factories—with a view to decisions being taken as to the best use to which they could be put in the national interest. The Government recognised the importance of reaching such decisions before the end of the war in as many cases as possible. Special attention was being paid to the release of factories urgently needed for peace-time production.

Railings for Scrap

MR. COLEGATE asked the Minister of Supply whether, in view of recent market reports that buyers were not appearing to be interested in old railings, of which there were large stocks, he would now reconsider the policy of removing such railings round schools, houses and other buildings.

SIR A. DUNCAN: Scrap railings are now being consumed at the steelworks at a greater rate than they are being collected, and reserve stocks are beginning to diminish. It is essential to continue the collection of railings, the need for this type of scrap being as great as when the scheme started.

NEW PATENTS

The following list of Patent Specifications accepted has been taken from the "Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. *each.*

556,495 ROBBINS, H. G. Method and means for the spinning or planishing of sheet metal.

556,502 BUTLER BROS. Concentration of ores.

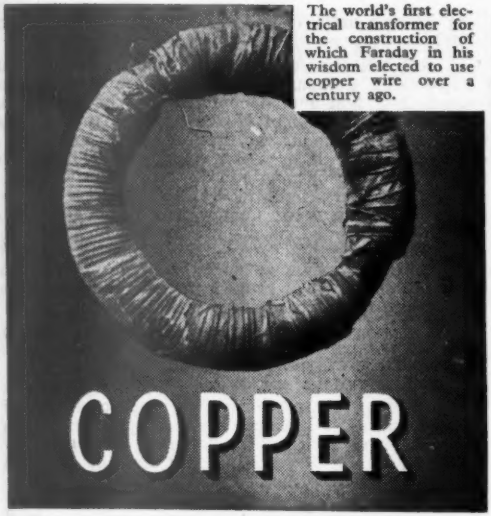
556,504 BRENNAN, J. B. Repeated impact testing machines.

556,561 BIRMINGHAM ELECTRIC FURNACES, LIMITED, and HANCOCK, P. F. Gaseous atmospheres for use in connection with the heat-treatment of materials.

CONTRACT OPEN

Any date given is the latest on which tenders will be accepted. The address is that from which tender forms may be obtained.

Belfast, November 29—Gas cookers, heating stoves and other appliances for 12 months from February 1, 1944, for the Town Council. The Engineer and Manager, Gasworks, Ormeau Road, Belfast.



The world's first electrical transformer for the construction of which Faraday in his wisdom elected to use copper wire over a century ago.

The metal that is associated with all progress

COPPER has been used by mankind from the most remote periods. Its influence at times has been revolutionary. Starting with the Bronze Age it has been found to be inseparable from all engineering progress ever since.

As its applications have increased and technical developments have become continuously more complex, problems have inevitably arisen which require specialised knowledge and experience for their solution. May we remind you that on matters relating to copper the Copper Development Association has such knowledge and experience and that its advisory service is at your disposal free of charge.

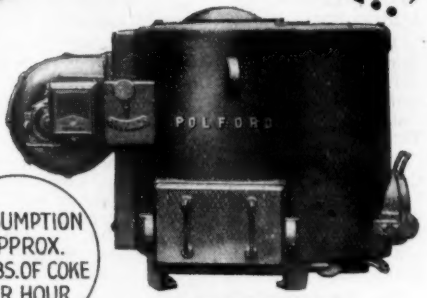
COPPER DEVELOPMENT ASSOCIATION

A non-trading organization maintained by the British Copper Industry to supply information and advice, free, to all users of copper.

Grand Buildings, Trafalgar Sq., London, W.C.2 and 9 Bilton Rd., Rugby
Telephone: only Rugby 2369

C14

BEYOND ALL DOUBT..



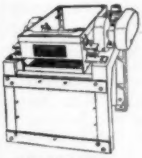
CONSUMPTION APPROX. 24 LBS. OF COKE PER HOUR

...THE MOST *Economical Dryer*

CRUCIBLE FURNACE

Designed for the drying of moulds in the floor or *in situ*, the "Polford" Portable Mould Dryer is definitely the most economical dryer of its kind. Strongly built and lined throughout with a special monolithic lining, ensuring long life and freedom from all lining trouble. Other special features are—Uniformity of Drying, Complete Control of Temperature, Self-contained and Adaptable.

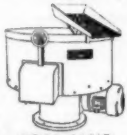
Can be adapted to stoves.



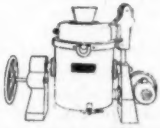
VIBRATORY SCREEN

"POLFORD" *Portable* MOULD DRYER

Other "POLFORD" Products



CORE SAND MIXER



TILTING FURNACE

THE HEATON FOUNDRY CO. LTD.
Makers of Foundry Equipment,
HEATON JUNCTION, NEWCASTLE UPON TYNE, 6

NEWS IN BRIEF

SIR GEORGE C. USHER has been elected a director of the Firestone Tyre & Rubber Company, Limited.

AFTER 70 YEARS' continuous service with C. & W. Walker, Limited, engineers, of Donnington, Salop, Mr. George Harris has retired at the age of 82.

THE CONTROLLER OF IRON AND STEEL, Ministry of Supply, has accepted with regret the resignation of Mr. Enos Smith, the Director for Wire Rods, Wire and Wire Products. Mr. A. Scott and Mr. N. Anderson, of the same department, have been appointed Directors.

FROM NOVEMBER 29, the temporary head office of the British Aluminium Company, Limited, will be Salisbury House, London Wall, London, E.C.2. From the same date the offices of the company at Shrewsbury, Shropshire, and at 68, Pall Mall, London, S.W.1, will be closed. Other addresses—London depot, Birmingham and Leeds offices—will be unchanged.

COL. SIR CHARLES WRIGHT, chairman and managing director of Baldwins, Limited, relinquishes the position of managing director of the company and also of Guest Keen Baldwins Iron and Steel Company, Limited, at the end of the year. Sir Charles, who until recently was Acting Controller of Iron and Steel, will continue as chairman of both concerns. Col. J. B. Neilson, vice-chairman, takes his place as managing director of Baldwins, Limited.

ACCORDING TO A. THUM and C. PETERSEN in the "Archiv für das Eisenhüttenwesen," cast iron behaves similarly to a notched steel bar under tensile and alternating stresses, although the fatigue strength cannot be directly calculated from the tensile values. Experience with notched steel bars under alternating stresses can thus be employed to some extent in the investigation of cast iron. The authors have derived curves by means of which the fatigue strength of cast iron can be determined from the tensile strength and the Brinell hardness.

THE INSTITUTION OF MECHANICAL ENGINEERS announces that, thanks to arrangements made by the War Organisation of the British Red Cross and the Order of St. John of Jerusalem, no less than 37 candidates recently sat for the Institution's examinations in Prisoner-of-War Camps in Germany. No fewer than 34, or 92 per cent., passed with an exceptionally high average percentage marking. The results reflect credit both on the candidates and on members of the Institution and others in the Camps who organised classes and acted as instructors.

A NEW WORLD'S RECORD for a single blast furnace was established in March by No. 3 stack of Jones & Laughlin Steel Corporation at Aliquippa, Pa., which produced 48,505 tons, at an average of 1,565 tons per day. The prior record was held by a Bethlehem Steel Company furnace at Lackawanna, N.Y., with 40,246 tons, made in October, 1942. Other new records were made by Jones & Laughlin works in March. The 44-in. blooming mill at Aliquippa rolled 171,440 tons of ingots for a new world record, breaking its own mark of 161,074 tons rolled in October, 1942.

THE FOREMEN'S ASSOCIATION of the Brush Electrical Engineering Company, Limited, Loughborough, convened their first annual conference at Loughborough during the week-end of November 5, 6, and 7. It is believed to be among the first of its kind in industry. Foremen from all over the country were invited to take part. The opening address, on "Industrial Relations," was given by Mr. R. Lloyd Roberts, Under-Secretary, Ministry of Labour and National Service. Mr. Alan P. Good, managing director of the Brush Electrical Engineering Company, said that the problem of foremanship was the biggest and most difficult in front of them. They could learn from other people's experience and exchange experiences with them.

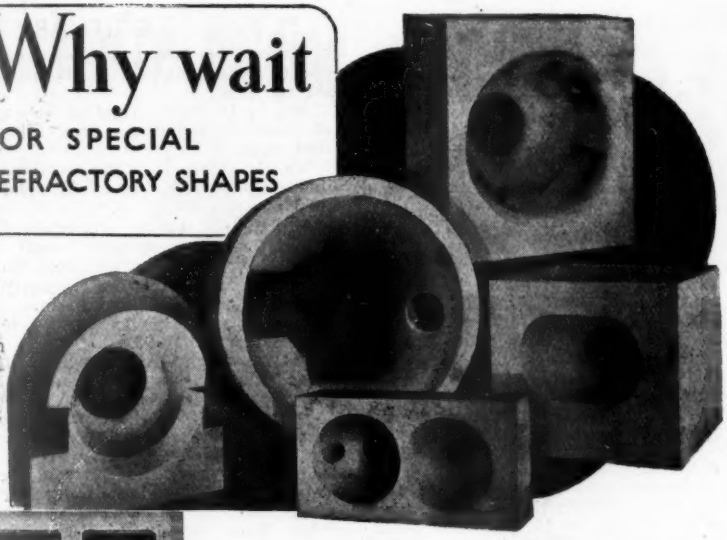
AT A MEETING of the (American) Association of Iron and Steel Engineers, J. T. Whiting, director, Steel Division, War Production Board, referring to the achievements of the American steel industry, said that the steel expansion programme was well over the half way mark. The electric furnace programme on October 1 was 85 per cent. complete, while the new blast furnace capacity was 64 per cent. in operation and open-hearth expansion 62 per cent. complete. Approximately 69 per cent. of the by-product coke-oven capacity scheduled to be built under the original expansion programme is now ready for operation, while the same percentage of the sintering expansion has been installed. Ore projects are 51 per cent. complete.

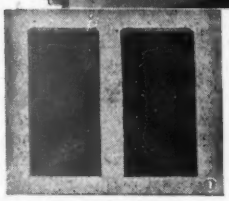
A SECOND BLAST FURNACE is said to have been blown in at Penhsihu in Manchuria early in the winter. The first furnace, it is claimed, was completed in October, 1941, and was making pig-iron in the following January. Two further furnaces, it is reported, are now being built. The additional iron ore required for the new furnaces is being supplied by the Tung Lien Tao Company. Further plans have also been implemented to increase the steel output of Manchuria, and last June a part of the second steelworks was put into commission, practically 88 per cent. of the total output now coming from this works. Exports to Japan, it is said, were greater in the first half of 1942 than in any previous six months.

UNITED STATES PRODUCTION of pig-iron and ferro-alloys during August, at 5,315,633 net tons, established a new all-time record by slightly exceeding the previous peak recorded in March last, according to the American Iron and Steel Institute. Total production in July amounted to 5,022,745 tons. On a day-rate basis (both months containing 31 days), output in August was at an average rate of 171,472 tons, as compared with 162,024 tons in July. Production in March was 5,314,201 net tons, or at a daily rate of 171,429 tons. Cumulative production for the first eight months of this year, amounting to 40,681,821 tons, is also a new all-time high for the period, exceeding the preceding record of last year by about 1,191,000 tons. Production during the first eight months of 1941 aggregated 35,879,208 net tons.

Why wait

FOR SPECIAL
REFRACTORY SHAPES





NO SHRINKAGE. Illustration (1) shows two blocks cast in moulds and dried at atmospheric temperature. One was fired to 1500° C for four hours. Specimens are the same size.

STRENGTH. Illustration (2) shows two test pieces cast in moulds, dried at atmospheric temperature and one heated to 1000° C. Tensile strength —*Unfired*, 550 lbs. per sq. in. *Fired*, 1312 lbs. per sq. in.

FIREBRICKS . BASIC BRICKS
ACID - PROOF MATERIALS
CEMENTS . PLASTICS
INSULATION . SILICA BRICKS
SILLIMANITE . SANDS

Make them quickly and economically

with DURAX No. 2

REFRACTORY CONCRETE

IN CASES of emergency, special shapes and replacements may be made quickly with Durax No. 2 Refractory Concrete. Mixed similarly to ordinary building concrete, Durax is poured into position, dries quickly and sets to a remarkable degree of hardness. There is no permanent volume change and tests have shown no signs of fusion below 1580° C—there is no tendency to crack or spall. Durax No. 2 is used for protection of header tubes and drums in water tube boilers, access door and lid linings, flame baffles, burner blocks, furnace and coke oven door linings, complete monolithic linings, small monolithic arches and all types of special shapes.

General Refractories
LIMITED

GENEFAX HOUSE SHEFFIELD, 10, ENGLAND.
TELEGRAMS: "GENEFAX. SHEFFIELD"

GR

33

COMPANY RESULTS

(Figures for previous year in brackets)

Thompson Bros. (Bilston)—Final dividend of 7½%, plus 7½% bonus, making 22½% (same).

Associated Equipment Company — Net profit, £227,500 (£141,500); dividend of 15%, less tax, and a bonus of 5%, tax free.

Henry Berry & Company—Net profit to August 31, after tax, £5,872 (£6,234); preference dividend, £1,800 (same); to reserve, £1,000 (nil); ordinary dividend of 15% (12½%), £3,750 (£3,125); forward, £9,350 (£10,028).

Masson, Scott & Company—Profit for year to March 31, 1943, £21,352 (£23,639); net profit, £6,179 (£6,111), after £10,161 (£12,075) for taxation; additional tax provision, £2,000; to provision for contingencies, £3,500; proposed dividend, 5%, with bonus of 5%; forward, £4,037 (£9,608).

Wilkes—Trading profit to July 31, £10,406 (£9,889); depreciation, £1,462 (£985); war damage insurance, £188 (£354); tax, £4,163 (£4,017); net profit, £3,593 (£4,134); to reserve, £2,000 (same); 7% preference dividend, £546 (same); ordinary dividend of 10%, £1,250 (same); forward, £2,463 (£2,666).

Walter Spencer & Company—Trading profit, etc., to September 30, £59,153 (£55,350); depreciation, £7,526 (£4,431); tax and E.P.T., £36,650 (£37,500); net profit, £14,127 (£12,536); dividend of 12½%, less tax, £6,250 (same); to reserve, £5,000 (same); war damage insurance, £589 (£827); forward, £24,423 (£22,135).

Davey Paxman & Company—Profit for year to March 31 last, after E.P.T., £43,064 (£30,808); income-tax, £27,289 (£19,476); debenture redemption, £1,500 (same); preference dividend, £1,000 (£510); ordinary dividend of 7½%, £3,187 (same); to general reserve, £5,000 (£3,000); post-war contingencies reserve, £5,000 (£3,000); forward, £8,042 (£7,954).

Fairfield Shipbuilding & Engineering—Profit for the year to June 30 last, after providing for taxation and depreciation, £95,949 (£97,694); interest on "A" mortgage debenture stock, £12,500; dividend on the 6% cumulative preference shares, £15,000; reserve for contingencies, £50,000; dividend of 10% on the ordinary shares (same); forward, £52,157 (£46,209).

Walter Somers—Profit for the year ended March 31, after making provision for taxation, £41,075; net profit, after £4,300 for debenture interest, £330 for A.R.P. and £17,140 for depreciation, £18,238 (£17,737); dividend on the 6½% employees' cumulative preference shares, £143; dividend of 1s. per share, less tax, on the ordinary shares, £8,750 (same); to deferred repairs and contingencies reserve, £10,000; forward, £37,341 (£37,996).

Frederick Braby & Company—Trading profit for the year to September 30, £320,583 (£302,426); dividend and interest income, £6,367 (£7,205); total revenue, £326,950 (£309,631); tax, £237,000 (£230,225); depreciation, £30,673 (£30,441); debenture interest and fees, £8,172 (£7,911); net profit, £51,105 (£41,054); ordinary dividend of 10% (same); to suspense reserve, £20,000 (£10,000); forward, after preference and employees' stock dividends, £62,234 (£62,354).

OBITUARY

SIR WILLIAM NOBLE, a director of the General Electric Company, Limited, died in London recently, at the age of 82.

MR. F. MARKHAM, chief of the wages department of of Appleby-Frodingham Steelworks, Scunthorpe, has died, aged 55.

MR. LEONARD FLETCHER, chairman and managing director of B. & S. Massey, Limited, Manchester, died on November 11.

MR. H. E. CALVERT, a director of Calvert & Company, Limited, engineers and ironfounders, of Huddersfield, died recently, aged 84.

MR. JOSIAH GREENHALGH, formerly proprietor of the Vulcan Ironworks, Oldham, Lancs., of J. Greenhalgh & Sons, from which he retired a few years ago, has died at the age of 90.

CAPT. THOMAS EATON BELCHER, of Wolverhampton, is reported killed on active service in the Middle East. Capt. Belcher, who was 27, was, before the war, assistant secretary of F. H. Lloyd & Company, Limited, James Bridge Steelworks, Wednesbury.

MR. ALLAN H. FINDLAY, who until 1941 had been for 28 years general secretary of the United Patternmakers' Association, has died in his 71st year. He was president of the Trades Union Congress in 1936.

MR. JOHN ANDERSON BALDERSTON has died at Paisley, aged 74. He was formerly a director of Fullerton, Hodgart & Barclay, Limited, ironfounders and engineers, Vulcan Works, Paisley.

MR. GEORGE WALTER JOHNSON, a well-known engineer, has died in London in his 67th year. He served his apprenticeship with John Readhead & Sons, Limited, shipbuilders and engineers, South Shields. He was the mechanical engineer in charge of the pumping plant, hydraulic cranes and lifts at the new Alexandra Dock, Bombay, and he erected the pumping machinery and sluice gates in a dry dock at Keppel Harbour, Singapore.

FLUORSPAR INDUSTRY

The Derbyshire Fluorspar Producers' Association was formed at a meeting held at Bakewell, when the following eight firms were elected to send representatives to act as an Executive Committee:—Clay Cross Company, Limited; Constables (Quarries), Ltd.; Bleaklow Mining Co.; James Wilkinson and Sons, Ltd.; G. T. West and Co.; Ernest Hinchliffe, Ltd.; Blanchland Fluor Mines, Ltd.; Wm. Smith (Fluor Spar), Ltd.

The Executive met on November 8, when the following officers were elected:—Chairman, Mr. Frederick Franks (Ernest Hinchliffe, Ltd.); deputy chairman, Mr. Charles A. Jones (Clay Cross Co.); Secretary, Mr. H. Hebblethwaite, 39, Foxwood Avenue, Sheffield, 2.

Immediate work of the Executive is to formulate rules, draw up standard grades and prices, consider the full report recently issued by the Control, which indicates the necessity of organising the industry on a sound basis, and contact the fluorspar producers in other parts of the country with the object of trying to develop a national organisation.

You're holding up more than a Transport vehicle!

IMMENSE work has been done so that rails, roads and canals shall be able to handle the vast war traffic. But still the loads and cargoes grow.

Can you do anything? Yes! you can. You can give us more 'running time' from every conveyance that brings or fetches your goods.

When you keep a wagon or lorry or canal-boat even an hour longer than necessary you not only hold up a vehicle. You hold up war traffic. When you free a vehicle you send it directly to the help of our fighting men. Remember *that* every time a vehicle comes to you.

You know your own problems best. Tackle them in your own way. But tackle them now. Plan, encourage ideas, improvise if needs be. Here's a starting-off agenda:

1. CLEAR LABELS AND DOCUMENTS
2. LABOUR SAVING DEVICES.
3. WORK IN BLACK-OUT AND AT WEEK-ENDS.
4. OPINIONS OF "MEN WHO DO THE WORK".

QUICKER TURNROUND THAN EVER BEFORE

Issued by the Ministry of War Transport

5

Raw Material Markets

IRON AND STEEL

At no period of the war have the consuming establishments been so amply provided with pig-iron. This is largely a reflection of the highly efficient manner in which the production and assembly of raw materials has been organised. The bulk of the ore which is being smelted is of low iron content, but the blast furnaces have adapted themselves to the altered conditions and, whatever the deficiencies in quality, quantitative production is ample for all needs. It is the fixed rule that no pig-iron can be supplied except under licence, but, subject to this condition, specifications for both high-phosphorus and low-phosphorus iron can be readily satisfied and, in regard to the latter, licensed consumers will henceforward be free to obtain their supplies from any convenient source. The makers of refined iron are now able to accept orders for reasonably prompt delivery; indeed, some of them are on the lookout for business. Hematite is still scarce and applications for licences are only granted after the most careful scrutiny.

All told, the demand for pig-iron is not now so keen as it was only a few months back. A better flow of ore has enabled production of the pig-irons needed by the engineering foundries to be increased, and this has coincided with a decline in the activity of some of the foundries. It is not yet clear whether this is a temporary phase, but certainly orders for some forms of armaments which involved a considerable tonnage of castings have fallen off.

Some of the changes in the related schedules lodged in connection with the latest Control of Iron and Steel Order are of interest to foundrymen. In the case of low- and medium-phosphorus pig-iron, the maximum charge for silky iron over 3 per cent. silicon is now only 2s. 6d. per ton, against 1s. 6d. to 17s. 6d. formerly. In the case of high-phosphorus iron, foundries will have to pay a little more. The extra was formerly 1s. per ton for iron, with silicon 4 per cent. and over; now it is 2s. 6d. per ton. There have been no changes in the extras for high-silicon hematite, which vary from 6s. up to 42s.

Raw materials other than pig-iron continue to be plentiful. There is no difficulty in securing deliveries of coke; in fact, the supply at the moment would appear to exceed the demand. Limestone, likewise, is in plentiful supply. In some areas stringency is evident in the scrap market, but foundry requirements as a whole appear to be fairly well covered. It is not always easy, however, to get supplies of heavy machinery cast-iron scrap. Short, heavy steel scrap, suitable for foundry work and refined pig-iron making, finds ready outlets.

To satisfy the requirements of the aircraft factories a big expansion in the production of special steels has been necessary. This, however, has been successfully accomplished and may have an important influence on the post-war structure of the steel industry. In regard to the production of semi-finished steel for re-rolling, also, the steel industry of Great Britain is approaching a state of self-sufficiency. Weekly deliveries have increased to such an extent that encroachments on reserve stocks of imported material have virtually ceased, although re-rollers still find it necessary to take up any available defective billets and other re-rollable material.

All the rolling mills are working to a carefully planned time schedule based upon a somewhat complex system of allocations. The justification of this procedure is that essential work is carried on with little or no interruption through lack of supplies. The demand for plates of all thicknesses is phenomenal, and scarcely less urgent is the call for light and medium sections. Interest in heavy joists is distinctly limited, but collieries and railways continue to make heavy calls for roofing material, rails, chairs, tyres and axles, and sheet mills have orders in hand which will keep them busy for months to come.

NON-FERROUS METALS

It is extremely gratifying and a tribute to the foresight of the authorities that, after more than four years of war, substantial stocks of tin should be held by Britain and America, particularly as we have for long been cut off from supplies from the Eastern tinfields. It is true that the passing of these fields into Japanese hands has meant the utmost economy in use and the employment of substitutes for many purposes, but it nevertheless remains that tin is still forthcoming promptly for essential purposes and that substantial stocks continue to be held. The position is even more satisfactory in the case of the other non-ferrous metals. Copper, lead and zinc are in adequate supply even with the greatly expanded wartime consumption, and no difficulty is envisaged in meeting all legitimate needs so long as hostilities continue.

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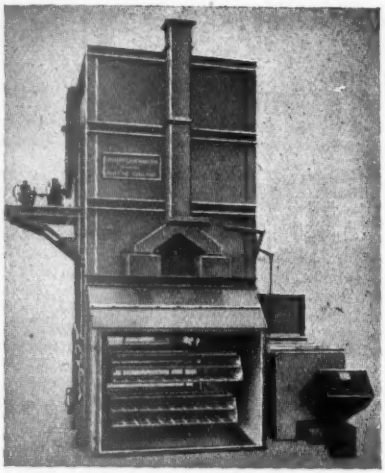

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CURRENT PRICES OF IRON, STEEL AND NON-FERROUS METALS

(Delivered, unless otherwise stated)

Wednesday, November 24, 1943

PIG-IRON

Foundry Iron.—CLEVELAND No. 3: Middlesbrough, 128s.; Birmingham, 130s.; Falkirk, 128s.; Glasgow, 131s.; Manchester, 133s. DERBYSHIRE No. 3: Birmingham, 130s.; Manchester, 133s.; Sheffield, 127s. 6d. NORTHANTS No. 3: Birmingham, 127s. 6d.; Manchester, 131s. 6d. STAFFS No. 3: Birmingham, 130s.; Manchester, 133s. LINCOLNSHIRE No. 3: Sheffield, 127s. 6d.; Birmingham, 130s.

(*No. 1 foundry 3s. above No. 3. No. 4 forge 1s. below No. 3 for foundries, 3s. below for ironworks.*)

Hematite.—No. 1 (S & P 0.03 to 0.05 per cent.): Scotland, N.-E. Coast and West Coast of England, 138s. 6d.; Sheffield, 144s.; Birmingham, 150s.; Wales (Welsh iron), 134s. East Coast No. 3 at Birmingham, 149s.

Low-phosphorus Iron.—Over 0.10 to 0.75 per cent. P, 140s. 6d., delivered Birmingham.

Scotch Iron.—No. 3 foundry, 124s. 9d.; No. 1 foundry, 127s. 3d., d/d Grangemouth.

Cylinder and Refined Irons.—North Zone, 174s.; South Zone, 176s. 6d.

Refined Malleable.—North Zone, 184s.; South Zone, 186s. 6d.

Cold Blast.—South Staffs, 227s. 6d.

(NOTE.—*Prices of hematite pig-iron, and of foundry and forge iron with a phosphoric content of not less than 0.75 per cent., are subject to a rebate of 5s. per ton.*)

FERRO-ALLOYS

(*Per ton unless otherwise stated, basis 2-ton lots, d/d Sheffield works.*)

Ferro-silicon (5-ton lots).—25 per cent., £21 5s.; 45/50 per cent., £27 10s.; 75/8C per cent., £43. Briquettes, £30 per ton.

Ferro-vanadium.—35/50 per cent., 15s. 6d. per lb. of V.

Ferro-molybdenum.—70/75 per cent., carbon-free, 6s. per lb. of Mo.

Ferro-titanium.—20/25 per cent., carbon-free, 1s. 3½d. lb.

Ferro-tungsten.—80/85 per cent., 9s. 8d. lb.

Tungsten Metal Powder.—98/99 per cent., 9s. 9½d. lb.

Ferro-chrome.—4/6 per cent. C, £59; max. 2 per cent. C, 1s. 6d. lb.; max. 1 per cent. C, 1s. 6½d. lb.; max. 0.5 per cent. C, 1s. 6¾d. lb.

Cobalt.—98/99 per cent., 8s. 9d. lb.

Metallic Chromium.—96/98 per cent., 4s. 5d. lb.

Ferro-manganese.—78/98 per cent., £18 10s.

Metallic Manganese.—94/96 per cent., carb.-free, 1s. 9d. lb.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms and Slabs.—BASIC: Soft, u.t., 100-ton lots, £12 5s.; tested, up to 0.25 per cent. C, £12 10s.; hard (0.42 to 0.60 per cent. C), £13 17s. 6d.; silico-manganese, £17 5s.; free-cutting, £14 10s. SIEMENS MARTIN ACID: Up to 0.25 per cent. C, £15 15s.; case-hardening, £16 12s. 6d.; silico-manganese, £17 5s.

Billets, Blooms and Slabs for Forging and Stamping.—Basic, soft, up to 0.25 per cent. C, £13 17s. 6d.; basic hard, 0.42 to 0.60 per cent. C, £14 10s.; acid, up to 0.25 per cent. C, £16 5s.

Sheet and Tinplate Bars.—£12 2s. 6d., 6-ton lots.

FINISHED STEEL

[*A rebate of 15s. per ton for steel bars, sections, plates, joists and hoops is obtainable in the home trade under certain conditions.*]

Plates and Sections.—Plates, ship (N.-E. Coast), £16 3s.; boiler plates (N.-E. Coast), £17 0s. 6d.; chequer plates (N.-E. Coast), £17 13s.; angles, over 4 un. ins., £15 8s.; tees, over 4 un. ins., £16 8s.; joists, 3 in. × 3 in. and up, £15 8s.

Bars, Sheets, etc.—Rounds and squares, 3 in. to 5½ in., £16 18s.; rounds, under 3 in. to ⅜ in. (untested), £17 12s.; flats, over 5 in. wide, £15 13s.; flats, 5 in. wide and under, £17 12s.; rails, heavy, f.o.t., £14 10s. 6d.; hoops, £18 7s.; black sheets, 24 g. (4-ton lots), £22 15s.; galvanised corrugated sheets (4-ton lots), £26 2s. 6d.; galvanised fencing wire, 8g. plain, £26 17s. 6d.

Tinplates.—I.C. cokes, 20 × 14 per box, 29s. 9d., f.o.t. makers' works, 30s. 9d., f.o.b.; C.W., 20×14, 27s. 9d., f.o.t., 28s. 6d., f.o.b.

NON-FERROUS METALS

Copper.—Electrolytic, £62; high-grade fire-refined, £61 10s.; fire-refined of not less than 99.7 per cent., £61; ditto, 99.2 per cent., £60 10s.; black hot-rolled wire rods, £65 15s.

Tin.—99 to under 99.75 per cent., £275; 99.75 to under 99.9 per cent., £276 10s.; min. 99.9 per cent., £278 10s.

Spelter.—G.O.B. (foreign) (duty paid), £25 15s.; ditto (domestic), £26 10s.; "Prime Western," £26 10s.; refined and electrolytic, £27 5s.; not less than 99.99 per cent., £28 15s.

Lead.—Good soft pig-lead (foreign) (duty paid), £25; ditto (Empire and domestic), £25; English, £26 10s.

Zinc Sheets, etc.—Sheets, 10g. and thicker, ex works, £37 12s. 6d.; rolled zinc (boiler plates), ex works, £35 12s. 6d.; zinc oxide (Red Seal), d/d buyers' premises, £30 10s.

Other Metals.—Aluminium, ingots, £110; antimony, English, 99 per cent., £120; quicksilver, ex warehouse, £68 10s. to £69 15s.; nickel, £190 to £195.

Brass.—Solid-drawn tubes, 14d. per lb.; brazed tubes, 16d.; rods, drawn, 11½d.; rods, extruded or rolled, 9d.; sheets to 10 w.g., 10⅞d.; wire, 10½d.; rolled metal, 10½d.; yellow metal rods, 9d.

Copper Tubes, etc.—Solid-drawn tubes, 15½d. per lb.; brazed tubes, 15½d.; wire, 10d.

Phosphor Bronze.—Strip, 13½d. per lb.; sheets to 10 w.g., 14½d.; wire, 16d.; rods, 16d.; tubes, 21½d.; castings, 19d., delivery 3 cwt. free. 10 per cent. phos. cop. £35 above B.S.; 15 per cent. phos. cop. £43 above B.S.; phosphor tin (5 per cent.) £40 above price of English ingots. (C. CLIFFORD & SON, LIMITED.)

Nickel Silver, etc.—Ingots for raising, 10d. to 1s. 4d. per lb.; rolled to 9 in. wide, 1s. 4d. to 1s. 10d.; to 12 in. wide, 1s. 4½d. to 1s. 10½d.; to 15 in. wide, 1s. 4½d. to 1s. 10½d.; to 18 in. wide, 1s. 5d. to 1s. 11d.; to 21 in. wide, 1s. 5½d. to 1s. 11½d.; to 25 in. wide, 1s. 6d. to 2s. Ingots for spoons and forks, 10d. to 1s. 6½d. Ingots rolled to spoon size, 1s. 1d. to 1s. 9½d. Wire round, to 10g., 1s. 7½d. to 2s. 2½d., with extras according to gauge. Special 5ths quality turning rods in straight lengths, 1s. 6½d. upwards.

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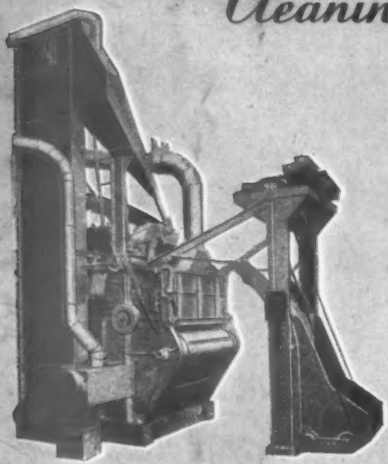

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